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Three sets of experiments compared skilled and unskilled college and school age (sixth through eighth grade) readers' processing of spoken and printed sentences in isolation and in story context. The two types of readers differed in their processing of the structural, thematic, and schematic properties of sentences in both reading and listening. The results demonstrated that reading and listening make use of similar language comprehension processes, that unskilled readers are also relatively unskilled listeners, and that effective comprehension involves an interaction of processes for perceiving and relating propositions and for integrating propositions with schematic expectations. School-aged unskilled readers were relatively deficient in propositional processing and tended to process spoken and printed sentences as a series of unstructured words. College-aged unskilled readers were relatively deficient in their strategies for relating propositions and tended to rely on expectations to form a representation of text. (Author/FL)

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COMPARISON OF SENTENCE PROCESSING IN LISTENING AND READING AMONG COLLEGE- AND SCHOOL-AGE SKILLED AND UNSKILLED READERS

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ABSTRACT

Three sets of experiments compared college-age and school-age (6th-8th grade) skilled and unskilled readers' processing of spoken and printed sentences in isolation and in story contexts. The two types of readers differed in their processing of the structural, thematic, and schematic properties of sentences in both reading and listening. The results demonstrate that reading and listening make use of similar language comprehension processes, that unskilled readers are also relatively unskilled listeners, and that effective comprehension involves an interaction of processes for (a) perceiving propositions, (b) relating propositions, and (c) integrating propositions with schematic expectations. School-age unskilled readers are relatively deficient in propositional processing, and tend to process spoken and printed sentences as a series of unstructured words. College-age unskilled readers are relatively deficient in their strategies for relating propositions, and tend to rely on expectations to form a representation of text.

Language comprehension involves the formation of a meaningful representation derived from a message. Beyond this general definition, there is a divergence of views on which aspects of the message determine the meaningful representation. The assumption of "proposition perception theory" (PPT), derived from research on auditory sentence comprehension, is that the linguistic stimulus carries the meaning of the message and that the task of comprehension is to extract that meaning (e.g., Fodor, Bever, & Garrett, 1974). In contrast, the assumption of "schema perception theory" (SPT), derived from research on the recall of printed texts, is that the linguistic stimulus provides only rough guidelines to the meaning of the message and that the reader constructs a meaning by using prior knowledge of the world and the organization of text (Adams & Collins, 1979; Rumelhart, 1980; Weaver, 1978). It may not be accidental that these distinct views derive from research on comprehension in two different modalities, listening and reading.

Reading and Listening Compared

The most salient aspect of reading is the recognition of words from the printed sequences of letters, which is obviously not a part of listening comprehension. Beyond this basic difference between reading and listening, there are some differences in the kinds of cues to structure and in the strategies available to the recipient of a message, but there are also similarities in morphemic cues to structure.

Speech contains numerous prosodic cues to sentence structure which are largely

absent in printed text. Breathing pauses tend to occur between clauses (Boomer, 1965; Goldman-Eisler, 1972); the last word of a clause is lengthened (Cooper & Cooper, 1980); there are characteristic pitch changes during a clause and at its end (Danley & Cooper, 1979); even individual within-clause phrases have typical prosodic features (Sorenson, Cooper, & Paccia, 1978). Speech that systematically lacks all of these characteristics is much harder to understand, suggesting that listeners normally rely on acoustically-analysable cues to segmentation (Huggins, 1978). Since intonational cues to phrase structure are not reliably present in printed text the reader must rely on morphemic cues to organize word sequences into phrases (Fries, 1962).

There are many morphemic ("function" words) and sequential cues to sentence and text structure common to spoken language and printed text (Bever, 1970; Forster & Olbrei, 1973; Townsend, 1983). Indeed, the syntactic rules that govern sentence acceptability are identical in speech and writing. In so far as comprehension relies on such cues to structure, reading and listening processes may be similar. Experiments with artificial languages have shown that it is very difficult to learn a language without such markers (Green, 1979; Moeser & Bregman, 1973). These results establish the possibility that both listeners and readers rely heavily on the patterns of such morphemes to provide an initial syntactic organization of messages.

Since listening comprehension often occurs in situations in which the speaker is present, questioning of the speaker may resolve failures in initial comprehension (see Rubin, 1980). The possibility of interacting with the speaker may allow the speaker to tailor the message in order to take into account "gaps" that may exist in the listener's knowledge. Since the writer is generally not available to clarify the printed message, the reader must construct a

representation of the meaning of text which is more dependent on background knowledge and expectations that s/he has brought to the situation.

The permanence of the printed message perhaps allows for greater flexibility in reading comprehension strategies than is available to the listener, who is more constrained by limited short term memory and by the order in which the speaker presents the message. The reader has the options of rereading unclear portions of text, using "headings" and looking ahead in order to derive an overall structure for the message, and skipping large portions of the message to look for certain ideas that s/he believes will be stated in the text. It may be the case that these options allow text structure to play a relatively greater role in reading comprehension than in listening comprehension.

Propositional Processing

Proposition Perception Theory has focused on how listeners isolate phrases and the relations between phrases. Listening involves two activities: isolating word groups that share potential phrase structure organizations, and integrating the meaning of each phrase with what came before and what might come after. Sequences of phrases that represent complete propositions are among the most important units of comprehension. For example a surface structure clause functions as a unit during comprehension (e.g., Fodor, Bever, & Garrett, 1974). During such a clause the listener assigns potential syntactical organizations (Bever, Garrett, & Hurtig, 1973; Marslen-Wilson & Tyler, 1975). At the end of such a clause, the listener assigns semantic roles to the words and phrases, and integrates the resultant meaning with previous material. When the listener determines a set of semantic roles within a clause and an interpretation for the whole clause and its role in discourse, memory for the exact words fades, freeing working memory for the words

in the subsequent semantic unit (Abrams & Bever, 1970; Caplan, 1972; Jarvella, 1971; Perfetti & Goldman, 1976; Townsend & Bever, 1978). Complete propositions also serve as a major unit of text processing (Townsend, 1983).

Kleiman (1975) has proposed a model of reading which corresponds in part to PPT. The reader retains words in a limited capacity working memory until a complete syntactic-semantic unit is obtained. At this point, an interpretation of the words in working memory is transformed into permanent memory, freeing working memory for the beginning of a new syntactic unit. Failure to segment syntactic units would produce word-by-word segmentation (as exemplified in certain beginning readers, "word callers," Smith, Goodman, & Meredith, 1976), and a failure to comprehend the propositions in the text.

There is some experimental evidence that the Proposition Perception Theory is true of reading. Reading comprehension improves when syntactic patterns correspond to common patterns in speech (Tatham, 1970). Readers spend more time reading and fixating on the last word of a clause (Aaronson, 1976; Just & Carpenter, 1980), presumably to integrate its meaning with what came before. The eye-voice span generally extends to the end of the major phrase, particularly for advanced readers (Gibson & Levin, 1975). Pauses in oral reading frequently occur at the ends of clauses (Goldman-Eisler, 1968, 1972). Other linguistic surface structure units such as noun-phrase and verb-phrase also elicit relatively large pauses in reading (Goldman-Eisler, 1972; Hawkins, 1971).

This evidence indicates that readers may impose an initial grouping of words by using the kinds of morpheme/sequence sensitive phrase structure strategies that they use in listening. They can develop such strategies in listening by first relying on the intonation patterns of speech, which redundantly signal many aspects of phrase organization. As they become more experienced listeners (and readers),

children can utilize perceptual strategies based on morphemic patterns alone: such a view would explain why inappropriate intonation has a lesser effect on listening comprehension of skilled readers than it does of unskilled readers (Oaken, Weiner, & Cromer, 1971).

The kinds of structural analyses identified in speech perception research differentiate readers of different levels of skill. Unskilled readers differ from skilled readers in their use of sentence structure while reading (Clay & Imlach, 1971; Cohen & Freeman, 1978; Cromer, 1970; Denner, 1970; Fry, Johnson,, & Muehl, 1970; Guthrie, 1973; Steiner, Weiner, & Cromer, 1971; Vogel, 1975; Weinstein & Rabinovitch, 1971). Cromer (1970), for example, has demonstrated that there are readers who are deficient in their comprehension of typically formatted printed materials, but not in their comprehension of material that is formatted to emphasize phrase structure groupings of words. Unskilled readers also differ from skilled readers in their use of cues to textual relations between clauses even while listening (Goldman, 1976; Perfetti & Goldman, 1976). For example, Perfetti & Goldman (1976) found that unskilled readers are not as sensitive as skilled readers to the structural distinctions between main and subordinate clauses.

Studies such as these suggest that improvement in reading beyond basic word recognition skills occurs by applying independently developed linguistic knowledge. From this point of view, reading deficits may be due to deficits in the application of de-coding strategies that the reader successfully applies during listening, or they may be due to impoverished linguistic knowledge which leads to poor comprehension in both listening and reading (see also Durrell, 1969; Sticht, 1972).

Thematic Processing

Schema Perception Theory (e.g., Pearson & Spiro, 1982; Schank, 1982; Weaver, 1978) proposes that readers use expectations based on prior knowledge ("scripts") and the organization of text to make inferences that connect propositions and to organize propositions in memory (Bartlett, 1932; Bower, Black, & Turner, 1979; Bransford & Johnson, 1973; Mandler & Johnson, 1977). The reader might also use such knowledge to establish predictions about what will appear next in the text, thereby facilitating sentence comprehension:

> "Activation of the overall script brings the activation level of script actions close to the firing threshold. Hence, relatively little sensory evidence directed to an action node is required in order for it to be perceived. Also, expected stimulus patterns should be identified rapidly because their logogens have been brought near firing threshold by the context alone." (Bower et al., 1979, p. 206).

That is, comprehension of a sentence should be easier when it is "predicted" by the schema underlying the text than when it is not (see also Abelson, 1981; Adams & Collins, 1979; Rumelhart & Ortony, 1977; Schank & Birnbaum, in press; Tyler & Marslen-Wilson, 1977). Recent evidence appears to support this claim of SPT: Sentences which violate expectations take longer to read (Bower, Black, & Turner, 1979; Duffy, 1983; Gibbs & Tenney, 1980; Townsend, 1983).

Such demonstrations, however, are also consistent with an "interactive" view, that integrative processes and propositional perception are independent processes (Cairns, Cowart, & Cablon, 1981; Townsend, 1983; Townsend & Bever, 1982). On the interactive view, context and expectations may influence integrative processing, but not syntactic processing. Townsend (1983) has shown that readers and listeners use morphemic cues to thematic structure, such as "if", "because", "after," "although", etc., as signals to integrate propositions with context and

expectations. For example, "because" is a signal to integrate immediately into a causal organization of text, but "although" is a signal to postpone integration. The fact that integrative processes operate on propositions is prima facie evidence that thematic processing does not affect propositional perception.

While it has not been shown that good and unskilled readers differ in their use of schemata for understanding sentences, there is evidence that unskilled readers' recall of both spoken and printed stories is less influenced by the thematic importance of propositions (Smiley, Oakley, Worthen, Campione, & Brown, 1977). Children who are unskilled readers are poorer at recalling the propositional structure of text, even when equated with skilled readers in terms of reading miscues (Bridge & Tierney, 1981; Tierney, Bridge, & Cera, 1979). Unskilled readers also differ from skilled readers in their knowledge of story structure (Stein, 1982). These studies suggest that deficits in reading comprehension may be associated either with deficits in "thematic processing" of the relations between propositions, or with deficits in "schema perception." Many instructional methods for teaching reading skills attempt to develop "previewing" and scanning strategies, but it is not clear how the organization provided by such strategies influence the process of comprehending text.

PPT and SPT Compared

The proposition and schema perception theories of comprehension represent contrasting views of reading and the acquisition of reading skills. These two theories make opposing predictions about the role of syntactic structure at different levels of reading skill.

PPT emphasizes a "bottom-up" approach to comprehension (Fodor, Bever, & Garrett, 1974; see also Gough, 1972; Kolers, 1970). According to PPT,

comprehension involves the formation of "higher" levels of structure from "lower" levels of structure. That is, letter (or phoneme) sequences are grouped into words, word sequences are grouped into phrases, phrase sequences are grouped into clauses or sentences that correspond to propositions, which in turn are semantically interpreted. Learning to read involves the transfer of listening strategies for relating levels of structure to reading. As the reader transfers more strategies to reading, the effects of sentence structure increase. It follows from PPT that sentence structure affects the performance of older and more skilled readers more than that of younger and less skilled readers.

SPT emphasizes a "top-down" approach to comprehension. For example, Schank (1982) views reading primarily as a process of predicting and inferring information based on the schemata that are activated by earlier portions of the text. The skilled reader is one who activates a schema, and looks for information in the text that can fill "empty slots" in the activated schema. Understanding a sentence that states an event that is typical of the situation described by the activated schema is more a matter of confirming expectations than it is performing a syntactic analysis of the sentence (cf. Bower et al., 1979). The unskilled reader, on the other hand, is either unfamiliar with the schemata that are needed to understand a passage, or does not activate schemata that are available in memory (Pearson & Spiro, 1982; Schank, 1982). Improvement in reading skill comes about through the accumulation and activation of relevant schemata during reading. It follows from SPT that the effects of sentence structure while reading will decline with increased reading skill and age. That is, sentence structure should affect the performance of younger and less skilled readers more than that of older and more skilled readers.

The modality differences between speech and printed text may be responsible

for these differing emphases on the nature of the comprehension process. The "bottom-up" emphasis of PPT was derived from research on auditory comprehension. Since the auditory message must be processed from left to right, the listener may rely more on morphemic, sequential, and intonational cues to meaning, and less on text organization. And since the speaker is often available to correct misunderstandings, the need for the listener to construct an idiosyncratic representation of meaning based in large part on prior knowledge may be reduced. The "top-down" emphasis of SPT was derived primarily from research on the recall of printed text. Since the printed message need not be processed in any particular order, the reader may rely less on sequence cues to meaning, and more on expectations and text structure.

What is at issue is the extent to which the differences in modality influence the role of the sentence as a unit of meaning. If the sentence is a unit of meaning in the formation of a representation of text, sentence structure must be perceived. A schema does not demand that a particular proposition appear in a particular form, or even that it appear at all in the message. The reader/listener may develop expectations based on a schema, but in order to confirm them, s/he must still engage in structural analysis of the sentences. However, the preceding discussion has raised the possibility that skilled comprehension strategies in reading may by-pass the sentence as a unit of meaning. Hence, skilled and unskilled readers may not differ in their comprehension of spoken language, which does not normally allow for the kinds of strategic processing that are possible in reading.

Overview of Tasks

Our research compared 3 sets of skilled and less-skilled readers at the

college- and school-age levels. The first two sets of subjects included college and 6th-8th grade students, and the last included only college students. For two sets of subjects, we used standardized verbal achievement scores as a basis for classifying subjects as skilled vs. unskilled readers, and for the third, we administered a variant of the Cook-Chapman test to distinguish skilled vs. unskilled readers.

The first set of subjects received 5 tasks primarily assessing listening comprehension processes. The second set of subjects received 2 tasks assessing syntactic processing and fluctuations of attention during reading. The third set of subjects received 2 tasks assessing thematic processing of printed sentences. Table 1 summarizes the tasks.

The first set of subjects received the following tasks: Story Reading, Story Listening, Tone Location, Meaning Probe, and Word Probe. In the two Story Tasks, subjects heard or read a story of moderate length, and received three tests assessing their comprehension of the story, their memory for words, and their literal memory for particular sentences in the story.

In the Tone Location task (Bever, Lackner, & Kirk, 1969), subjects heard an isolated sentence with a tone superimposed on speech around the clause boundary. The subjects' task was to indicate the location of the tone in the sentence. Accuracy in locating the tone when it occurred before, in, or after the clause boundary indicates the effect of segmentation into syntactic units on the fluctuations of attention to nonlinguistic sounds.

The Meaning Probe task (Townsend & Bever, 1978) assesses the listener's accessibility to the meaning of a sentence as s/he hears it. In this task, the subject heard a sentence fragment ending before the clause boundary, and then a short phrase. The subject's task was to say as quickly as possible whether the

phrase was similar in meaning to the sentence fragment. With this task we examined the subjects' "on-line" processing of the structural distinction between main and subordinate clause and the thematic distinction between "if" clause and "though" clause.

The Word Probe task (Townsend & Bever, 1978) assesses the listener's on-line accessibility to the words and their order in a sentence. This task was similar to the Meaning Probe task, except that after hearing the sentence fragment, the subject heard a single word, and said whether or not the word had occurred in the sentence. As in the Meaning Probe task, we examined structural and thematic processing of isolated auditory sentences.

The second set of subjects received two reading tasks: the Find-the-Odd-Word task and the E-Detection task. In the Odd-Word task (adapted from the Cook-Chapman test), subjects read paragraphs for the purpose of detecting a word that did not fit the meaning of the paragraph. We examined the effect on detection time of formatting the paragraphs so that phrase boundaries coincide with the ends of lines, and classified subjects as "unskilled readers" if "chunked" formats had a large effect on their performance.

In the E-Detection task, subjects crossed out /e/s as they read isolated sentences. This task is based on Corcoran's (1966) finding that the letter /e/ is easier to detect in printed text when it corresponds to a spoken syllable than when it is silent. In our task, we examined detection accuracy for silent /e/s depending on whether they occurred in words at the end or beginning of a clause. A focus of attention on internal comprehension processes associated with the end of a clause should produce more failures to detect silent /e/s.

The third set of subjects received a Sentence Reading task in which they read stories one clause at a time. The time spent reading each clause was measured.

Story pairs were constructed so that a single clause described an event which was either of high or low relevance to the script underlying the story. These critical clauses were introduced by either "because" or "although". After reading the stories, the subjects received a test for their memory of the meaning vs. superficial form of the critical clauses.

Our results showed that the listening skills of skilled and unskilled readers differ in a variety of ways. Within each level of reading skill, there are also age differences in comprehension processes. Skilled and unskilled readers differ in their use of thematic and structural cues to relations between sentences. The skilled college-age reader quickly forms an abstract representation from the "bottom-up" by using structural cues to the relation between propositions. The unskilled college-age reader treats each sentence as independent, and relies on a "top-down" strategy for obtaining sentence meanings; s/he focuses less on relating the meanings of propositions, and relies more on a strategy of obtaining an approximation of text meaning through the application of schemata. At the school-age level, the skilled reader listens and reads in many ways like the unskilled college-age reader, treating sentences as independent.

METHODS

A. Listening Skills

Subjects. Forty-eight subjects were selected on the basis of standardized reading test scores (Scholastic Aptitude Test for college students, Standardized Achievement Test for school-age students). Twenty-four subjects were Columbia University students, ranging in age from 18 to 35. Twelve of the college students were "skilled readers" (VSAT 610 or higher, mean 658, standard deviation 38.9), and twelve were "unskilled readers" (VSAT 560 or lower, mean 490, standard deviation 40.2). Twenty-four subjects were 6th, 7th, and 8th grade students at the Woodward School in Brooklyn, N.Y. (a private school), ranging in age from 10 to 13. Twelve of the school-age students were "skilled readers" (reading at least one grade above current grade level, with a mean of 3.9 grades above level, standard deviation 1.04), and twelve were "unskilled readers" (reading within or below current grade level, with a mean of 0.2 grades above level, standard deviation 1.21).

All subjects spoke English as their first language, and all were right-handed. There were six male subjects in each group defined by age and reading ability. Three subjects in each age, reading ability, and sex group had no left-handed relative, and three did (cf., Carrithers, Bever, & Townsend, in preparation, for discussion of this variable).

Skilled readers were paired with unskilled readers of the same age. The subjects were selected so that the members of these pairs had similar quantitative achievement test scores (at the college level, skilled readers: mean = 588, standard deviation = 80.2, unskilled readers: mean = 599, standard deviation = 75.9; at the school level, skilled readers: mean = 2.75 above grade, standard deviation = 2.49, unskilled readers: mean = 1.82, standard deviation = 1.61). The

college-age unskilled readers were an average of 12 points higher on QSAT (standard deviation 25.1) than the skilled readers with whom they were paired; the school-age unskilled readers were an average of 0.9 grades lower on QSAT (standard deviation 2.07) than the skilled readers with which they were paired. Contrasting with these "controls" over quantitative achievement scores, the college-age unskilled readers were, on the average, 168 points lower on VSAT (standard deviation 63.8), and the school-age unskilled readers were 3.67 grades lower on verbal achievements (standard deviation 1.68). Subjects within pairs of skilled and unskilled readers were "yoked" so that they received identical experimental materials. Subjects were tested individually in each of five tasks.

Procedure. 1. Story Reading. In one task, subjects read a factual story, and then answered questions assessing their comprehension of the story, and indicated whether particular words and sentences appeared in the story. Each subject received 2 stories drawn from a pool of 12 stories from the SAT Study Guide (1979) for adults, and from the McCall-Crabbs Standard Test Lessons in Reading, Books D and E, for school-age subjects (see Table 2). The stories for college-age subjects were 550 words long, and those for school-age subjects were 200 words long. Typed versions of these stories were presented to the subjects for reading. Following each story, subjects read and answered items in a three-part test. Each part contained 12 items for college-age subjects, and 6 items for school-age subjects. The first part was a set of two-choice comprehension questions (Table 3), the second was a set of words to be classified as having appeared or not appeared in the story, and the third was a set of sentences to be classified as having appeared or not appeared in the story. Distractors (i.e., false choices) for each of these tests were semantically plausible for the story (see Table 4).

Each subject read stories under two levels of time pressure. College-age subjects were allowed to read one story for 180 sec, and the other for 90 sec.

School-age subjects were allowed to read 90 sec for one story and 45 sec for the other. The faster reading condition always followed the slower reading condition.

2. Story Listening. In a second task, tests identical to the reading tests were administered after the subject listened to a story. Each subject listened to two stories that were different from those s/he read in the Story Reading task, but were drawn from the same pool of 12 stories. The three tests following each story were presented by tape recorder. Half the subjects in each group heard the stories in the right ear, and half in the left.

Each subject listened to stories under two levels of time pressure: the stories were recorded either at the normal rate of speech (3 words per sec) or at twice the normal rate of speech (6 words per sec). The speeded tape was prepared by a speech compression system that deletes pauses in speech. Test items were presented at the normal rate of speech. Subjects received the slower version before the faster version.

3. Tone Location. A third task required the subject to listen to a sentence which had a brief tone superimposed on speech near a clause boundary, and then to identify where the tone had occurred (cf., Bever, Lackner, & Kirk, 1969). Half the subjects in each group heard the sentences in the right ear, and a 100 msec, 10,000 Hz tone and white noise in the left; the sentence and noise was presented in the opposite ear for the other half of each group.

There were nine critical sentences. Across 3 lists the tone occurred in each critical sentence in the syllable before the clause boundary, in the clause boundary, and in the syllable after the clause boundary (see Table 5). After hearing a critical sentence, the subject received a printed version of the sentence with a "window" encompassing 5 syllables and showing the approximate location of the tone. The window was centered around the actual location of the tone. The subject's task was to indicate with a slash the exact location of the tone.

There were 9 sentences which did not contain a tone. In order to determine guessing patterns, subjects were instructed to guess where a tone occurred even if they were uncertain if they had heard one. In three sentences each, the window centered was centered around the clause boundary, around the syllable before the clause boundary, or around the syllable after the clause boundary.

For 9 additional trials, the subjects did not receive a printed version of the sentence, but instead received a printed instruction to write out the sentence and indicate the location of the tone. These trials were included in order to require the subjects to listen to the sentence rather than just identify the tone.

4. Meaning Probe. In a fourth task the subject listened to a sentence fragment followed by a 2-4 word verb-object phrase, which the subject had to classify as being consistent or inconsistent with the meaning of the sentence fragment (as in Townsend & Bever, 1978). There were 6 critical cases in which the fragment ended before the last word of either an initial main clause or an initial subordinate clause (introduced by "if" or "though"). In the critical cases the phrase was similar in meaning to a part of the fragment (see Table 6). There were 18 filler trials which interrupted the final clause, used different conjunctions, or in which the phrase was not similar in meaning to any part of the sentence fragment. The fragment ended with a 50 msec, 500 Hz tone, which the subject heard and which triggered a timer. The phrase was heard 1/3 sec after the tone. Half the subjects heard the sentences and phrases in the right ear, and half heard them in the left ear. Sentence fragments were recorded by a male speaker, and phrases were recorded by a female speaker.

5. Word Probe. A fifth task was similar to the fourth, except that the subject had to indicate whether or not a probe word had occurred in the fragment (cf., Caplan, 1972; Townsend & Bever, 1978). The critical cases again were those in which the probe word had occurred in an initial main or subordinate clause (see

Table 6). An additional variable was the location of the target word in the fragment. Materials were constructed so that a single word could occupy two different positions in the fragments without changing its meaning. The "early" and "late" positions of the target word were separated by at least 2 words, with an average of 2.9 words. Half the subjects heard the sentences and probes in the right ear, and half heard them in the left ear. The recordings of the fragment lists were identical to those used in the Meaning Probe tasks, and the word probes were recorded by the same female speaker who recorded phrase probes. As in the Meaning Probe task, a tone marked the end of the fragment, and the probe followed 1/3 sec later.

Two sets of materials were prepared for the Meaning Probe and Word Probe tasks. In each set there were 6 lists with variations of target location and conjunction in the critical sentences; each list contained one instance of each combination of conjunction and target location in positive, initial clause trials. Individual subjects received a list from one set in the Meaning Probe task and a list from the other set in the Word Probe task, but across subjects, each set of materials appeared in both Meaning Probe and Word Probe.

B. Segmentation while Reading

Subjects. Sixty undergraduates from Nassau Community College and 35 sixth and eighth grade subjects from the Mt. Hebron School in Montclair participated. The subjects were tested in groups of 15-25 for a 1/2 hour period.

Procedure. 1. Odd Word Test. The subjects first received a portion of the Cook-Chapman find-the-odd-word test. Subjects read 12 paragraphs and crossed out a single word that did not fit in with the meaning of the rest of the paragraph. When they had finished half of the paragraphs, they recorded the time showing on a digital display clock with 6 in. characters, which had been started at the

beginning of each half of the test. The paragraphs were presented either in "chunked" format, with the ends of lines falling at constituent boundaries, or in "random" format, with the ends of lines falling within constituent boundaries (Table 7). Half the subjects read 6 "chunked" paragraphs followed by 6 "random" paragraphs; the other half of the subjects received the two formats in the opposite order.

2. /e/ Detection. In the second part the subjects read 14 sentences, making a slash through each /e/ as they read. They were instructed to read each sentence only once, and to cross out the /e/s as they read. It was emphasized that they should read the sentence well enough to answer a comprehension question that appeared after each sentence, and that they should complete the task in a certain time interval, which was set at the median time that pretest subjects of comparable age required to complete the task.

There were 4 sets of six test sentences. In each set of test sentences there was a critical word with either a silent or pronounced /e/ occurring either at the end of the initial clause or at the beginning of the final clause (see Table 8). Within each set, the serial position of the critical word, the words surrounding the critical word, and the total number of silent and pronounced /e/s were all controlled. The pronounced and silent versions of a pair with common clause boundary conditions occurred in different halves of two booklets. Each booklet contained 3 sentences in each combination of clause boundary condition and type of /e/ word. The booklets contained a filler sentence at the beginning and end of the list of 12 critical sentences. The page following each of the 14 sentences presented a comprehension question about the sentence on the preceding page.

C. Thematic Processing while Reading

Subjects. The subjects were 48 undergraduates at Montclair State College and

at Columbia University, who participated as part of a course requirement. The subjects were classified as skilled vs. unskilled readers on the basis of verbal Scholastic Aptitude Test scores. Unskilled readers had VSAT scores under 510, mean = 432; skilled readers had VSAT scores over 540, mean = 612.

Materials. There were 8 pairs of stories based on routine activities such as watching TV vs. eating breakfast, going to school vs. an amusement park, getting ready for bed vs. getting sick, going to the movies vs. a shopping mall, etc. There was one clause identical in the members of a pair of stories. The story pairs were constructed so that the event in common would be nearly essential to the situation described by one member of a pair, but only possible in the situation described by the other member of the pair (see Table 9). The common event occupied the same serial position within story pairs, ranging from the 4th-7th sentence.

We presented different members of the story-context pairs, followed by the common event, to 22 college students and asked them to rate how essential the common event was to the plot of the story. Their ratings confirmed our judgments that one member of each pair was more essential to the situation than the other. The average essentialness rating for "high relevance" stories was 3.8, for "low relevance" 2.3, $F\ (1,157) = 66.4$, $p < .001$.

In the experiment, the event that was common to the members of a pair of stories was introduced by "because" or "although". Conjunction was crossed with script relevance so that each subject received two stories with each combination of conjunction and script relevance. In eight lists, each common event appeared with each combination of conjunction, relevance, and word order.

Procedure. Subjects read the stories clause by clause on a TRS-80 computer screen. When the subject was finished reading a clause, s/he pressed a button which recorded the time spent on that clause, removed the clause from the screen, and displayed the next clause of the story. In order to acquire practice in using

the computer, the subjects read instructions in similar fashion on the computer screen. They were instructed to read the stories for the purpose of constructing a title, which they wrote after each story. After reading the 8 stories, they either recalled the stories as completely as possible, or took a sentence recognition test. On the recall test, subjects were given their own titles as cues for recalling the stories. Items on the recognition test were either identical to sentences containing the common events, or contained a shift in word order which did not change the meaning. Subjects were asked to check off from a list of 8 sentences those that they thought had occurred in the stories, and to rate on a 4 point scale how confident they were of each decision.

RESULTS

Our overall results indicate that college-age skilled readers listen and read at a more abstract level, rapidly converting form into meaning (see Table 10). Comparing skilled and unskilled college-age readers, the skilled reader makes fewer comprehension errors but more sentence recognition errors while listening to stories, is poorer at detecting /e/s while reading sentences, is slower at recognizing words from a sentence that s/he has been listening to, and reads clauses faster. At the school level, the unskilled reader performed more poorly as well on tasks requiring attention to the superficial form of the stimulus (Sentence Memory, Word Probe, E-Detection).

Table 11 summarizes the major findings regarding differences between skilled and unskilled readers on sentential and thematic processing. College-age skilled and unskilled readers differ in how they process the relations between clauses: the unskilled reader treats each sentence as a separate unit, while the skilled reader focuses on cues to structural and thematic relations between sentences, and processes information with different relations in different ways. Differences

between skilled and unskilled readers were similar across age levels, with three exceptions:

(1) There was a reversal in the effect of the clause boundary on tone location for skilled and unskilled readers at the college-age. This suggests that at a certain point in the acquisition of listening comprehension skills, the individual shifts away from treating clauses as independent units, and begins to process the relations between clauses.

(2) The main-subordinate distinction while listening and the clause boundary while reading had greater effects for skilled readers at the college-age than for skilled readers at the school level. This suggests that as comprehension skills increase, the individual increasingly processes different structures in different ways.

(3) The differences between skilled and unskilled readers on the effects of thematic cues ("if" vs. "though") were smaller at the college level than at the school level. This difference was primarily due to a very small effect of these cues for good school-age readers.

These differences suggest that the sentence processing associated with skilled and unskilled reading differ at the college- and school-age levels. Unskilled reading at the school level consists of a lack of segmentation of words into clausal units. The skilled school-age reader segments words into clausal units, but largely ignores processing the relations between clauses. The unskilled college reader segments words into clausal units but has difficulty recoding these units into propositions, and also applies inappropriate strategies for relating clauses. The skilled college reader rapidly focuses on relations between clauses and modifies clausal processing strategies accordingly.

A. Listening Skills

1. Reading vs. Listening to Stories. Analysis of variance was performed on the percentage of errors with reading ability, age, modality, rate of presentation, and task (comprehension questions, word recognition, and sentence recognition). Table 12 presents these data collapsed over rate of presentation, which did not interact with reading ability or modality, though errors were more frequent overall in the faster rate of presentation, $F(1,44) = 14.4$, $p < .001$, and rate interacted with task, $F(2,88) = 3.98$ (the faster rate increased word recognition errors by 10%, comprehension errors by 4 %, but had no effect at all on sentence recognition errors).

There were two major results of the story listening and reading tasks. First, skilled readers made fewer errors than unskilled readers, $F(1,44) = 5.86$. Second, reading ability did not interact with any other variable, including modality, $F < 1$. These results indicate that the unskilled reader is also relatively poor at listening.

2. Structural Segmentation. Tone location accuracy and guessing patterns are shown in Tables 13 and 14 respectively. Overall, tone location accuracy was higher for tones located in the clause break than for tones occuring before or after the clause break, $F(2, 138) = 16.6$, $p < .01$, and guesses were also more often located in the clause break, $F(2, 138) = 16.1$, $p < .01$. These data replicate previous studies which have demonstrated that clause structure influences attention to acoustic stimuli (e.g., Bever, Lackner, & Kirk, 1969).

In order to compare subjects of different reading ability and age, we calculated a "tone index" which is a measure of the effect of clause structure on overall accuracy (Carpenter, 1976). The tone index is the percentage of tones correctly reported in the break minus the average percentage of tones correctly located out of the break. In order to examine the effect of response bias, we calculated a corresponding "guess index", which is the percentage of tones guessed

to be in the clause break when the window was centered around the break, minus the average percentage of tones guessed to be in the center of the window when the window was not centered around the break. Since the window was always centered around the actual tone location, the two indices are comparable, and the guess index is a measure of the subject's awareness of where processing load is greatest and where failures in perception might have occurred.

The most striking aspect of the tone location results is that reading ability had different effects on the tone index at different age levels. At the college level, skilled readers showed a lower tone index than did unskilled readers, but at the school level, the reverse was true. The interaction between reading ability and age was significant, $p < .05$ by Wilcoxon test. For the guess index, there were no significant effects of age or reading ability, nor was there an interaction between these variables, suggesting that response bias does not account for the observed effects of clause structure on tone location accuracy. It appears that school-age skilled readers and college-age unskilled readers process clauses independently, but that school-age unskilled readers and college-age skilled readers do not.

There was one overall difference between skilled and unskilled readers: skilled readers were more accurate in locating tones before rather than after the clause boundary, $p < .05$ by sign test, but unskilled readers were equally accurate before and after the boundary, $p > .25$.

3. On-Line Access to Meaning and Superficial Form. The results of the Meaning Probe Task and Word Probe Task are shown in Tables 15 and 16 respectively. These tasks showed that skilled college-age readers process main clauses more rapidly for meaning, but retain the superficial form of subordinate clauses relatively longer. Unskilled readers at both age levels showed very different effects of clause structure, as compared to skilled college-age readers, and skilled school-age

readers showed practically no effect of clause structure. The processing differences between "if" and "though" for the various groups were similar to those that each group showed for main and subordinate clauses overall.

Skilled and unskilled readers differed in their processing of structurally distinct clauses. On the Meaning Probe Task, skilled readers were faster overall on main clauses (2534 msec) than on subordinate clauses (2681 msec), but the opposite was found for unskilled readers (2965 vs. 2743 msec), $F(1,88) = 9.2$, $p < .01$. It is notable, however, that the good school-age reader showed no difference between main and subordinate clauses, $F < 1$. On the Word Probe Task, skilled readers showed greater effects of target position in subordinate clauses (an 87 msec advantage for early targets) than for main clauses (a 34 msec advantage), but unskilled readers showed greater effects of target position in main clauses (a 151 msec advantage for early targets) than in subordinate clauses (a 17 msec advantage for late targets), $F(1,88) = 6.9$, $p < .05$.

Skilled and unskilled readers processed "if" and "though" clauses in partially similar ways. On the Meaning Probe Task, both types of readers responded more quickly to "if" clauses than to "though" clauses, for skilled readers, $F(1,40) = 3.03$, $p < .10$, for unskilled readers, $F(1,40) = 15.9$, $p < .01$. On the Word Probe Task, skilled readers showed greater evidence of left-to-right serial search in "though" clauses than in "if" clauses, $F(1,40) = 8.99$, $p < .01$, suggesting greater accessibility to superficial form in "though" clauses. Unskilled school-age readers showed this effect, $F(1,40) = 14.7$, $p < .01$, but unskilled readers did not.

B. Segmentation while Reading

For school-age subjects overall, reading times for finding the odd word were 7% faster in "chunked" paragraphs than in "randomly-formatted" paragraphs; for college-age subjects, the effect of "chunking" was less than 1%. Based on Cromer's

(1970) findings that unskilled readers' performance is more affected by formatting according to phrase structure, we used reading times on the Odd Word test to classify subjects as good vs. unskilled readers. We determined the median improvement in reading time for chunked formats relative to random formats. Subjects whose improvement was greater than the median were classified as unskilled readers.

There was evidence for auditory recoding of the printed sentences during reading. On the /e/ detection task, silent /e/s were harder to detect than pronounced /e/s for both college and school-age students, $p < .10$ by sign test, confirming Corcoran's (1966) results. The fact that pronounced /e/s are easier to detect during reading indicates that the reader forms an auditory representation of the words.

Table 17 shows that clause final silent /e/s were harder to detect than clause initial silent /e/s for college-age subjects, $p < .01$ by sign test, and moderately harder to detect for school-age subjects, $p = .11$. Table 17 also indicates that at the college-age, skilled readers showed a strong effect of the clause boundary on detection of silent /e/s, $p < .01$, but unskilled readers did not, $p > .10$. For school-age subjects, there were also differences in boundary effects for skilled readers, $p < .05$, but not for unskilled readers, $p > .25$.

The /e/ detection results demonstrate a direct effect of linguistic organization on reading, which reduces visual attention to the printed page at the end of a clause. The increase in the effect among skilled readers suggests that it reflects improved reading strategies. It also reflects a fluctuation in visual attention, not auditory processes. We conclude that skilled readers use strategies that are sensitive to the propositional structures of language in the same way as the auditory strategies of speech comprehension. The broad implication is that skilled reading involves comprehension strategies that have been transferred from

the auditory to the visual mode. The fact that younger subjects do not show the effect as strongly as older subjects suggests that the younger subjects have not fully transferred these strategies from the auditory to the visual mode.

C. Thematic Processing while Reading

1. Reading Time. Average reading times for the critical clauses are shown in Table 18. Overall, skilled readers read the critical clauses faster than did unskilled readers, $F(1,33) = 5.04$, $p < .01$. High relevance events were read faster than low relevance events, $F(1,33) = 4.45$, $p < .05$, and "although" clauses were read faster than "because" clauses, $F(1,33) = 4.25$, $p < .05$. As in the Meaning and Word Probe listening tasks, both types of readers appear to be sensitive to the different thematic meanings cued by "although" and "because," and process clauses introduced by these conjunctions in different ways. However, script relevance, conjunction, and type of reader interacted.

For skilled readers, there was no overall effect of script relevance, $F(1,33) < 1$. The skilled readers read "although" clauses faster than "because" clauses when the clause stated a high relevance event, $F(1,33) = 6.25$, $p < .05$, but not when it stated a low relevance event, $F < 1$.

For unskilled readers, reading times were faster for high relevance events, $F(1,33) = 8.06$, $p < .01$, and for events introduced by "although", $F(1,33) = 6.80$, $p < .05$. The conjunction effect was significant for low relevance events, $F(1,17) = 16.5$, $p < .01$, but not for high relevance events, $F(1,17) = 1.32$.

These results demonstrate that skilled and unskilled readers use schemata in reading, but in different ways. Good readers use schemata for the purpose of thematic integration. For high relevance events, "although" signals that the expected event is less important and the reader quickly moves on to the more important main clause which follows, presumably in order to discover what the

story-teller had expected to follow from the event in the "although" clause (Townsend, 1983). "Because" signals that the expected event is important and that its meaning should be retained for integration with the following event. Unskilled readers use schemata as a means of deriving sentence meanings: when events are consistent with the schema underlying text, surface cues have little effect on comprehension processes. The fact that surface cues have an effect only when the event is unexpected suggests that the unskilled reader's dominant mode of processing is a schematic one; relations between clauses become important only when the events are not expected.

2. Memory. Recognition results were converted to an 8-point scale: each confidence rating was assigned a positive sign if correct and a negative sign if incorrect. Positive recognition scores were generated by adding 5 to each signed score. The result was a range of scores from 1 to 8, with 8 indicating the highest possible recognition score. Table 19 shows the effects of script relevance and conjunction on skilled and unskilled readers' ability to detect changes in the word order of the critical clauses.

The recognition results suggest that the unskilled reader attends more closely to low relevance events than to high relevance events (cf. Bower et al., 1979), but that the reverse is true for skilled readers. For unskilled readers, ability to detect changes in word order was better for low relevance events than for high relevance events, $F(1,28) = 7.11$, $p < .05$. For skilled readers, literal memory was nonsignificantly better for high relevance events, $F(1,28) = 1.73$, $P > .10$. Overall, changes in word order were easier to detect in "because" clauses than in "although" clauses, $F(1,28) = 4.76$, $p < .05$.

Three judges rated the protocols for adequacy of recalling the propositional content of the critical events. The judges' ratings were highly correlated, with correlation coefficients of .74, .81, and .83. There were no overall differences

in propositional recall for skilled and unskilled readers, or for "because" vs. "although" clauses overall. The meaning of high relevance events was recalled 12% better than that of low relevance events, $F(1,14) = 9.18$, $p < .01$. For unskilled readers, the relevance effect was 15%, $F(1,14) = 8.58$, $p < .05$; for skilled readers, the effect was 8%, $F(1,14) = 2.04$, $p > .10$. Over the two types of readers, the relevance effect was significant in "although" clauses, $F(1,14) = 5.94$, $p < .05$, but not in "because" clauses, $F < 1$.

The memory results as a whole indicate that the unskilled reader's memory for stories is much more affected by schemata than is that of skilled readers. The unskilled reader shows better retention of the meaning of high relevance events, but better retention of superficial form of low relevance events.

DISCUSSION

Our research indicates that language processing differences between skilled and unskilled readers are much more extensive than had been considered previously. We found differences in structural and thematic processing in nearly all of the reading and listening tasks that we administered, despite our controls for general intelligence. In fact, the differences between college- and school-age subjects of high reading ability were generally much smaller than the differences between skilled and unskilled readers at the college level.

Our results suggest that reading and listening comprehension share many of the same processes. In the wide range of tasks we used, differences in task performance between skilled and unskilled readers nearly always emerged in both reading and listening. We observed differences between skilled and unskilled readers in "free" reading of stories, in listening to stories, in listening to

isolated sentences, in reading isolated sentences, and in sentence-by-sentence reading of stories. In the Story Reading and Listening tasks, in which we controlled for materials but varied modality, differences between skilled and unskilled readers at the school level were always greater in listening than in reading, and at the college level, differences in comprehension were greater in listening than in reading. In both the Meaning and Word Probe tasks, which involved listening to isolated sentences, and the Sentence Reading task, which involved reading sentences in story contexts, we found similar differences between skilled and unskilled readers in their use of cues to thematic relations.

These results strongly support the conclusions of Sticht (1972), Perfetti & Goldman (1976), and others, that deficits in reading skills are accompanied by deficits in listening skills as well. Within the limits of our experimental tasks, readers and listeners use similar strategies in the two modalities, whether those strategies are effective or not. The fact that so many differences between skilled and unskilled readers occurred in our listening tasks suggests that instructional programs should focus on the improvement of comprehension skills in both reading and listening.

Our research allows a preliminary description of the comprehension processes of skilled and unskilled readers at two age levels. Using terminology developed in the introduction, our results suggest that the unskilled school-age reader is a "word caller" not only in reading (Smith et al., 1976), but in listening as well; this individual tends to process spoken and printed language simply as a series of words without structure. The skilled school-age reader is a "proposition perceiver", who recodes word sequences corresponding to clauses into their propositional meaning, but engages in relatively little processing of the relations between propositions. The unskilled college-age reader is a "schema perceiver," who imposes schematic knowledge on the meanings of sentences and texts, perhaps as

a means of compensating for ineffective proposition perception processes. The skilled college-age reader is an "interactive processor", who modifies clausal processing strategies depending on structural, thematic, and schematic properties of text.

For the college-age skilled reader, reading and listening comprehension involves an interaction between proposition perception processes and schema perception processes, rather than complete reliance on either proposition perception or schema perception. For this type of reader, bottom-up analyses of sentences produce syntactic and propositional representations. The skilled college-age reader manipulates these products in different ways depending on thematic and structural cues to the relations between propositions, and depending on how they relate to expectations. Integrative processes tend to occur toward the end of propositional units rather than near the beginning. The results of propositional processing are the units on which integrative processes operate (cf., Townsend, 1983; Townsend & Bever, 1982).

The college-age unskilled reader does not exhibit these interactions between structural and thematic processing, perhaps because bottom-up analyses of sentences produce incomplete propositional representations. The tone location task demonstrated that the college-age unskilled reader does segment sentences into clauses. However, the /e/ detection task demonstrated that the unskilled college-age reader does not focus internal analysis at the end of the clause to as great an extent as does the skilled college reader. The Meaning and Word Probe tasks showed that the unskilled reader does not process main and subordinate clauses in the same way as the skilled reader, but that the unskilled reader shows greater differences in the processing of "if" and "though" clauses, as compared to the skilled reader. The sentence reading task showed that these differences between skilled and unskilled readers in thematic processing of clauses occur in

reading as well as in listening, but that the unskilled reader engages in more "schematic" predictions of sentence meaning. In short, the skilled college-age reader organizes word sequences into clauses, but but the products of the bottom-up internal analysis of sentence meanings are predominantly superficial rather than semantic. As a result, the unskilled reader does not form a representation of text from the propositions and their structurally and thematically cued relations, but instead utilizes schematic expectations to develop an approximation of the meaning of text.

The school-age skilled reader is similar to the unskilled college-age reader in segmenting the linguistic stimulus into clause units, but, unlike the unskilled college reader, s/he shows very few differences in the processing of structurally or thematically distinct clauses. The skilled school-age reader focuses internal analysis of sentence meaning at the ends of clauses. The skilled reader at this level is adept at perceiving propositions, but processes text as a series of unrelated propositions.

The school-age unskilled reader primarily processes spoken and printed language word by word. The phenomenon observed by Smith et al. (1976) in reading appears to operate in the auditory modality as well. This individual does not segment sentences into clauses while listening and, relative to the unskilled college reader, engages in even less internal analysis at the end of a clause while reading. In addition, the unskilled reader at the school level does not process main and subordinate clauses in different ways, but does respond to thematic cues in the same way as the unskilled college-age reader. The school-age unskilled reader appears to possess many of the inefficient processing strategies that the college-age unskilled reader possesses, but with the additional problem of not segmenting text into propositional units.

One factor emerges in the acquisition of effective reading skills: a shift

from clause by clause processing of language to a modification of clausal processing strategies, depending on cues in the text and on expectations, for the purpose of thematic integration of sentences. There were three major differences between skilled readers at the college and school levels: (1) Structural and thematic cues to clausal relations have smaller effects at the school level. (2) Boundary effects in /e/ detection are smaller at the school level. (3) The boundary effect in tone location accuracy is greater at the school level. These differences indicate that the skilled reader at the school level focuses on bottom-up, clause by clause processing in reading and listening; the skilled reader at the college level modifies these clausal processing strategies to focus on the thematic and structural relations between clauses. Improvement in reading skill among skilled readers between school and college involves improvement in strategies for integrating clauses with context.

Processing for the meaning of individual clauses is largely mastered by the skilled reader at the school level. Good reading skills at the school level are characterized by relatively simple clausal processing strategies: segmenting the word sequences into phrase and clause groupings, and interpreting clausal meaning at the ends of clauses. The structural and thematic relations between clauses interact very little with these clausal processes in school-age skilled readers. At the college level, however, the skilled reader modifies clausal processing strategies depending on structural and thematic cues to clausal relations and on the schematic context of the clause.

Our research suggests some directions for the improvement of instructional programs. Unskilled readers at the school level need to be more aware of phrase structure groupings of words and of sentences as units of meaning, and how within-sentence groupings of words relate to the meaning of a sentence. Attention to the intonation patterns of spoken language, practice in reading phrases rather

than individual words, listening to skilled readers imposing intonation on printed language would be helpful in increasing proposition perception processes at this level. Awareness of sentences as units of meaning, and of morpheme-sequence cues to meaning might be increased by practice in expressing propositions in alternative sentence forms. Our research suggests that simply emphasizing word recognition skills would reinforce the ineffective processing strategies that unskilled school-age readers already possess, and simply emphasizing recognition of the schemata that underlie texts would accelerate the acquisition of the ineffective processing strategies that unskilled college readers utilize.

The unskilled college-age reader needs instruction at three levels: how phrase structure groupings of words are organized as propositions, how texts signal the relations between propositions, and how these signals relate to importance, expectations, presupposition, and thematic organization. Awareness of the various structural and thematic cues to sentence relations might be increased by highlighting in various ways different cues, as suggested by Marzano (1978).

The fact that unskilled readers also possess a wide range of ineffective listening strategies suggests that programs for teaching reading should be integrated with programs for improving general comprehension skills. It might also be helpful to integrate programs for improving comprehension skills with writing and subject matter areas, so that instruction can be given in the relations between the internal structure of sentences and sentence meanings, and in the relations between sentence meanings and expectations.

REFERENCES

Aaronson, D. Performance theories for sentence coding: Some qualitative observations. Journal of Experimental Psychology: Human Perception and Performance, 1976, 2, 42-55.

Abelson, R.P. Psychological status of the script concept. American Psychologist, 1981, 36, 715-729.

Abrams, K. & Bever, T.G. Syntactic structure modifies attention during speech perception and recognition. Quarterly Journal of Experimental Psychology, 1969, 21, 280-290.

Adams, M.J. & Collins, A. A schema-theoretic view of reading. In R.O. Freedle (Ed.), New directions in discourse processing, Vol. II. Norwood, N.J.: Ablex, 1979.

Bartlett, F.C. Remembering: An experimental and social study. Cambridge: Cambridge University Press, 1932.

Bever, T.G. The cognitive basis for linguistic structures. In J.R. Hayes (Ed.), Cognition and the development of language. New York: Wiley, 1970

Bever, T.G., Garrett, M., & Hurtig, R. The interaction of perceptual processes and ambiguous sentences. Memory and Cognition, 1973, 1, 277-286.

Bever, T.G., Lackner, J.R., & Kirk, R. The underlying structures of sentences are the primary units of immediate speech processing. Perception and Psychophysics, 1969, 5, 225-234.

Boomer, D.S. Hesitation and grammatical encoding. Language and Speech, 1965, 8, 148-158.

Bower, G.H., Black, J.B., & Turner, T.J. Scripts in memory for text. Cognitive Psychology, 1979, 11, 177-220.

Bransford, J.D. & Johnson, M.K. Consideration of some problems of comprehension. In W.G. Chase (Ed.), Visual Information Processing. New York, Academic Press, 1973.

Bridge, C.A. & Tierney, R.J. The inferential operations of children across texts with narrative and expository tendencies. Journal of Reading Behavior, 1981, 13, 201-214.

Cairns, H.S. , Cowart, W., & Jablon, A. Effects of prior context upon the integration of lexical information during sentence processing. Journal of Verbal Learning and Verbal Behavior, 1981, 20, 445-453.

Caplan, D. Clause boundaries and recognition latencies for words in sentences. Perception and Psychophysics, 1972, 12, 73-76.

Carpenter, M. Sensitivity to syntactic structure: Good versus poor

premorbid schizophrenics. Journal of Abnormal Psychology, 1976, 85, 41-50.

Carrithers, C., Bever, T.G., & Townsend, D.J. Hemispheric specialization for speech comprehension in skilled vs. unskilled readers. In preparation.

Clay, M. & Imlach, R. Juncture, pitch and stress as reading behavior variables. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 133-139.

Cohen, G. & Freeman, R. Individual differences in reading strategies in relation to handedness and cerebral asymmetry. In J. Requin (Ed.), Attention and performance, VII. Hillsdale, N.J.: Erlbaum, 1978.

Cooper, W. & Cooper, L. Studies in speech production. Cambridge, Mass.: Harvard University Press, 1980.

Corcoran, D.J.W. An acoustic factor in letter cancellation. Nature, 1966, 210, 658.

Cromer, W. The difference model: A new explanation for some reading difficulties. Journal of Educational Psychology, 1970, 61, 671-683.

Danley, M. & Cooper, W.E. Sentence production: Closure vs. initiation of constituents. Journal of Linguistics, 1979, 17, 1017-1038.

Denner, B. Representational and syntactic competence of problem readers. Child Development, 1970, 41, 881-887.

Duffy, S. Predictive processing in story comprehension. Eastern Psychological Association, 1983.

Durrell, D.D. Listening comprehension vs. reading comprehension. Journal of Reading, 1969, 12, 455-460.

Fodor, J.A., Bever, T.G., & Garrett, M.F. The psychology of language. New York: McGraw Hill, 1974.

Forster, K., & Olbrei, I. Semantic heuristics and syntactic analysis. Cognition, 1973, 2, 319-347.

Fry, M., Johnson, C., & Muehl, S. Oral language production in relation to reading achievement among select second graders. In D. Bakker & P. Satz (Eds.) Specific reading disability: Advances in theory and method. Amsterdam: Rotterdam University Press, 1970.

Fries, C.C. Linguistics and reading. New York: Holt, Rinehart, & Winston, 1962.

Gibbs, R.W. & Tenney, Y.J. The concept of scripts in understanding stories. Journal of Psycholinguistic Research, 1980, 9, 275-284.

Gibson, E.J. & Levin, H. The psychology of reading. Cambridge: M.I.T. Press, 1975

Goldman, S. Reading skill and the minimum distance principle: A

comparison of listening and reading comprehension. Journal of Experimental Child Psychology, 1976, 22, 123-142.

Goldman-Eisler, F. Pauses, clauses, and sentences. Language and Speech, 1972, 15, 103-113.

Goldman-Eisler, F. Psycholinguistics: Experiments in spontaneous speech. New York: Academic Press, 1968.

Gough, P.B. One second of reading. In J.F. Kavanagh & I.G. Mattingly (Eds.), Language by ear and by eye. Cambridge, Mass.: MIT Press, 1972.

Green, T.R. The necessity of syntax markers: Two experiments with artificial languages. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 481-496.

Guthrie, J.T. Reading comprehension and syntactic responses in good and poor readers. Journal of Educational Psychology, 65, 1973, 294-299.

Hawkins, P.R. The syntactic location of hesitation pauses. Language and Speech, 1971, 14, 277-288.

Huggins, A.W.F. Timing and speech intelligibility. In J. Requin (Ed.), Attention and performance, VII. Hillsdale, N.J.: Erlbaum, 1978.

Jarvella, R.J. Syntactic processing of connected speech. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 409-416.

Just, M.A. & Carpenter, P.A. A theory of reading: From eye fixations to comprehension. Psychological Review, 1980, 87, 329-354.

Kleiman, G.M. Speech recoding in reading. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 323-339.

Kolers, P.A. Three stages of reading. In H. Levin & J.P. Williams (Eds.), Basic studies on reading. New York: Basic Books, 1970.

Mandler, J.M. & Johnson, N.S. Remembrance of things parsed: Story structure and recall. Cognitive Psychology, 1977, 11, 111-151.

Martin, J.G. On judging pauses in spontaneous speech. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 75-78.

Marslen-Wilson, W. & Tyler, L. The processing structure of sentence perception. Nature, 1975, 257, 784-786.

Marzano, R.J. Teaching psycholinguistically-based comprehension skills using a visual approach: A proposal. Journal of Reading, 1978, 729-734.

Moeser, S.D. & Bregman, A.S. The role of reference in the acquisition of a miniature artificial language. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 70-78.

Oaken, R., Weiner, M., & Cromer, W. Identification, organization, and reading comprehension for good and poor readers. Journal of

Educational Psychology, 1971, 62, 71-78.

Pearson, P.D. & Spiro, R. The new buzz word in reading is schema. Instructor, 1982, 46-48.

Perfetti, C. & Goldman, S. Discourse memory and reading comprehension. Journal of Verbal Learning and Verbal Behavior, 1976, 15, 33-42.

Rubin, A. A theoretical taxonomy of the differences between oral and written language. In R.J. Spiro, B.C. Bruce, & W.F. Brewer (Eds.), Theoretical issues in reading comprehension. Hillsdale, N.J.: Erlbaum, 1980.

Rumelhart, D.E. Schemata: The building blocks of cognition. In R.J. Spiro, B.C. Bruce, & W.F. Brewer (Eds.), Theoretical issues in reading comprehension. Hillsdale, N.J.: Erlbaum, 1980.

Rumelhart, D.E. & Ortony, A. The representation of knowledge in memory. In R.C. Anderson, R.J. Spiro, W.E. Montague (Eds.), Schooling and the acquisition of knowledge. Hillsdale, N.J.: Erlbaum, 1977.

Schank, R.C. Reading and understanding: Teaching from the perspective of artificial intelligence. Hillsdale, N.J.: Erlbaum, 1982.

Schank, R.C. & Birnbaum, L. Memory, meaning, and syntax. In T. Bever & L. Miller (Eds.) Cognitive, philosophical, and computational foundations of language. Hillsdale, N.J.: Erlbaum, in press).

Smith, E.B, Goodman, K.S., & Meredith, R. Language and thinking in the school. New York: Holt, Rinehart, & Winston, 1976.

Smiley, S., Oakley, D., Worthen, D., Campione, J., & Brown, A. Recall of thematically relevant material by adolescent good and poor readers as a function of written vs. oral presentation. Journal of Educational Psychology, 1977, 69, 381-387.

Sorenson, J.M., Cooper, W.E., & Paccia, J.M. Speech timing of grammatical categories. Cognition, 1978, 6, 135-153.

Sticht, T.G. Learning by listening. In J.B. Carroll & R.O. Freedle (Eds.), Language comprehension and the acquisition of knowledge. Washington, D.C.: V.H. Winston, 1972.

Stein, N.L. What's in a story: Interpreting the interpretations of story grammars. Discourse Processes, 1982, 5, 319-336.

Steiner, R., Weiner, M., & Cromer, W. Comprehension training and identification training for poor and good readers. Journal of Educational Psychology, 1971, 62, 506-513.

Tatham, S.M. Reading comprehension of materials written with select oral language patterns: A study at grades two and four. Reading Research Quarterly, 1970, 5, 402-426.

Tierney, R.J., Bridge, C., & Cera, M.J. The discourse processing operations of children. Reading Research Quarterly, 1979, 14,

539-573.

Townsend, D.J. Thematic processing in sentences and texts. Cognition, 1983, 13, 223-261.

Townsend, D.J. & Bever, T.G. Natural units of representation interact during sentence comprehension. Journal of Verbal Learning and Verbal Behavior, 1982, 21, 688-703.

Townsend, D.J. & Bever, T.G. Interclause relations and clausal processing. Journal of Verbal Learning and Verbal Behavior, 1978, 17, 509-521.

Tyler, L.K. & Marslen-Wilson, W.D. The on-line effects of semantic context on syntactic processing. Journal of Verbal Learning and Verbal Behavior, 1977, 16, 683-692.

Vogel, L. Syntactic abilities in normal and dyslexic children. Journal of Learning Disabilities, 1974, 7, 103-109.

Weaver, P.A. Comprehension, recall, and dyslexia: A proposal for the application of schema theory. Bulletin of the Orton Society, 1978, 28, 92-123.

Weinstein, R. & Rabinovitch, M. Sentence structure and retention in good and poor readers. Journal of Educational Psychology, 1971, 62, 25-30.

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Table 1

Summary of Experiments

TASKS:

A. Listening Skills

1. Story Reading: comprehension & memory of printed text
2. Story Listening: comprehension & memory of spoken text
3. Tone Location: detection of tones around clause boundaries
4. Meaning Probe: on-line access to meaning of spoken sentences
5. Word Probe: on-line access to word order of spoken sentences

B. Segmentation while Reading

1. Odd Word: effects of format on reading time
2. /e/ Detection: detection of /e/s around clause boundaries

C. Thematic Processing while Reading

1. Reading Time: reading time for schematically relevant clauses
2. Sentence Recognition: literal memory for schematically relevant clauses
3. Recall: propositional memory for schematically relevant clauses

SUBJECTS:

A. 24 college students and 24 6th-8th graders

B. 60 college students and 35 6th-8th graders

C. 48 college students

Table 2

Sample Materials for School-Age Subject's Story Reading and Listening

STORY:

Sixty planes were on a practice flight. Our base was an aircraft carrier miles away over the horizon. Our earphones crackled an order from the carrier to return as quickly as possible. A storm had been sighted. The carrier had changed course and was racing toward us while we raced toward it.

The carrier came up over the horizon at full speed. On its trail we soon saw a wall of fog and rain.

Section after section of the planes peeled off and went down to land. The carrier's deck was rising and falling, rolling from side to side, and pitching from end to end. One plane struck the rising stern and crashed. Another hit the deck so hard, it bounced off the ship into the sea.

Only half the planes were on deck when we went into the wall of mist and rain. The ship disappeared from the sight of all of us except those in the planes that were low, ready to land. All the planes remaining in the air lined up and followed the leader just in front. A break of just one lin in that chain might have meant a watery grave for all behind.

Table 3

Sample Questions for School-Age Subject's Story Reading and Listening

1. The base for these airplanes was

   a. at sea.

   b. in the clouds.

2. The carrier changed course

   a. because it had to be in sight at all times.

   b. to reach the planes before the storm broke.

3. The writer says that the fog was

   a. rising and falling.

   b. like a wall.

4. How many planes reached their base before the storm struck them?

   a. thirty

   b. sixty

5. The planes landed on their base

   a. after trying twice.

   b. with difficulty.

6. Why did the planes line up?

   a. the ship disappeared

   b. the fog limited their visibility.

Table 4

Sample Word and Sentence Recognition Items for School-Age Subject's Story Reading and Listening

A. WORDS:

1. chain
2. lurching
3. wet
4. disappeared
5. discovered
6. crackled

B. SENTENCES:

1. The carrier came up over the horizon at full speed.
2. The deck of the carrier was pitching from end to end, rolling from side to side, and rising and falling.
3. All the planes remaining in the air lined up and followed the leader just in front.
4. Our earphones crackled an order from the carrier to return as quickly as possible.
5. The carrier was racing towards us while we raced towards it and had changed course.
6. Except for those in the planes that were low, ready to land, the ship disappeared from the sight of all of us.

Table 5

Sample Materials for Tone Location Task

1. Because coffee spilled on her <sky-blue dr*ss she went> home early.

2. Because coffee spilled on her sk<y-blue dress*she went ho>me early.

3. Because coffee spilled on her sky-<blue dress s*e went home> early.

NOTE: *=tone location, <>=window markers.

Table 6

Sample Materials for Meaning and Word Probe Tasks

MEANING PROBE:

{Though / If / ∅} I liked calling up my aunt each night at...USING THE TELEPHONE

{Though / If / ∅} I liked calling my aunt up each night at...USING THE TELEPHONE

WORD PROBE:

{Though / If / ∅} I liked calling up my aunt each night at...UP

{Though / If / ∅} I liked calling my aunt up each night at...UP

Table 7

Sample Formats in the Odd Word Test

CHUNKED:

Johnny came walking into the dining room
with very dirty shoes after playing all day,
and his angry mother sent him
to clean his teeth
and told him he was a bad boy.

RANDOM:

Johnny came walking into the dining room with
very dirty shoes after
playing all day, and
his angry mother sent
him to clean his teeth and
told him he was a bad boy.

Table 8

Sample Materials for the /e/ Detection Task

1. The teacher in charge of the Indian hunters had to take hunting lessons.

2. The teacher in charge of the Indian natives had to take hunting lessons.

QUESTION FOR 1 AND 2:

What did the lessons teach?

.....how to catch rabbits

.....how to catch fish

3. To learn some new ways the Indian hunters had to take hunting lessons.

4. To learn some new ways the Indian natives had to take hunting lessons.

QUESTION FOR 3 AND 4:

Who could use these lessons?

.....people who want to find deer

.....people who want to play baseball

Table 9

Sample Stories in Thematic Processing Tasks

HIGH RELEVANCE:

Johnny woke up very hungry for breakfast. He found a bowl and a spoon in the kitchen. He got a pitcher of milk from the refrigerator. Although he took down a box of Cheerios from the shelf,...

LOW RELEVANCE:

Johnny was watching his favorite programs on TV. He started to get hungry for a snack. He waited for a commercial to go into the kitchen. Although he took down a box of Cheerios from the shelf,...

Table 10

Overall Task Performance of Unskilled Readers Relative to Skilled Readers of the Same Age

TASK	COLLEGE-AGE UNSKILLED READERS	SCHOOL-AGE UNSKILLED READERS
Story Reading	18% more errors	15% more errors
comprehension	24% more errors	21% more errors
word memory	14% more errors	15% more errors
sentence memory	15% more errors	11% more errors
Story Listening	10% more errors	39% more errors
comprehension	43% more errors	78% more errors
word memory	11% more errors	36% more errors
sentence memory	10% fewer errors	18% more errors
Tone Location	9% more errors	37% fewer errors
Meaning Probe	4% faster	18% slower
Word Probe	12% faster	21% slower
/e/ Detection	10% fewer errors	9% more errors
Sentence Reading	17% slower	--

Table 11

Overall Effects of Sentential and Thematic Structure for Skilled and Unskilled Readers

A. COLLEGE LEVEL

	Skilled Reader	Unskilled Reader
Tone Location:		
Boundary Effect	23%	40%
Meaning Probe:		
Main/Sub	main 9% faster	main 13% slower
If/Though	if 4% faster	if 6% faster
Word Probe:		
Main/Sub	main 8% faster	main 1% slower
If/Though	if 3% faster	if 6% slower
/e/ Detection:		
Boundary Effect	24%	8%
Sentence Reading		
Script Relevance:	relevant event 1% faster	relevant event 10% faster
Because/Although:		
Relevant:	although 10% faster	although 2% faster
Not Relevant:	although 5% faster	although 13% faster

Table 11 (continued)

Overall Effects of Sentential and Thematic Structure for Skilled and Unskilled Readers

B. SCHOOL

	Skilled Reader	Unskilled Reader
Tone Location:		
Boundary Effect	40%	31%
Meaning Probe:		
Main/Sub	main 2% faster	main 4% slower
If/Though	if 1% faster	if 7% faster
Word Probe:		
Main/Sub	no difference	main 2% faster
If/Though	if 3% faster	if 9% slower
/e/ Detection:		
Boundary Effect	10%	2%

Table 12

Results of Story Tasks

A. Percentage Errors on Story Reading Tasks

	College-Age		School-Age	
	Skilled	Unskilled	Skilled	Unskilled
Comprehension	21	26	19	23
Recognition Memory for Words	24	28	26	30
Recognition Memory for Sentences	39	45	36	41
Mean	28	33	27	31

B. Percentage Errors on Story Listening Tasks

	College-Age		School-Age	
	Skilled	Unskilled	Skilled	Unskilled
Comprehension	21	30	18	32
Recognition Memory for Words	28	31	28	38
Recognition Memory for Sentences	41	37	40	47
Mean	30	33	28	39

Table 13

Results for Tone Trials

A. Percentage of Tones Correctly Located

	College-Age		School-Age	
Tone Location	Skilled	Unskilled	Skilled	Unskilled
In Break	57.7	65.3	57.6	61.0
Before Break	44.5	29.1	25.0	37.5
After Break	25.0	20.8	9.7	31.2
Mean	42.4	38.4	32.0	43.9
Tone Index	25.6	40.2	40.0	30.9

B. Percentage of Errors Mislocated into Clause Boundary

	College-Age		School-Age	
Tone Location	Skilled	Unskilled	Skilled	Unskilled
Before Break	46.7	43.3	29.5	61.7
After Break	53.1	83.4	68.8	60.6
Mean	49.9	63.4	49.2	61.2

Table 14

Results for No-Tone Trials

A. Percentage of Guesses Located in Window Center in No-Tone Trials

	College-Age		School-Age	
	Skilled	Unskilled	Skilled	Unskilled
In Break	38.8	39.9	27.8	38.6
Before Break	11.0	5.5	27.8	24.8
After Break	8.3	0	2.8	19.3
Mean	19.3	15.1	19.7	25.7
Guess Index	29.3	37.6	18.0	16.7

B. Percentage of Guesses "Mislocated" away from Window Center into Clause Boundary in No-Tone Trials

	College-Age		School-Age	
	Skilled	Unskilled	Skilled	Unskilled
Before Break	40.3	45.8	47.2	36.2
After Break	36.1	61.2	34.8	16.5
Mean	38.2	53.5	41.0	26.4

Table 15

Mean Response Times (msec) on Meaning Probe Task

COLLEGE-AGE	If	Main	Though
Skilled	2636	2446	2756
Unskilled	2323	2721	2477
Mean	2480	2584	2617
SCHOOL-AGE			
Skilled	2645	2622	2684
Unskilled	2981	3208	3191
Mean	2813	2915	2938
OVERALL	2646	2749	2777

Table 16

Mean Response Times (msec) on Word Probe Task

	If		Main		Though	
COLLEGE-AGE	Early	Late	Early	Late	Early	Late
Skilled	2028	2147	1835	2058	1969	2343
Unskilled	1815	1905	1854	1788	1818	1688
Mean	1922	2026	1845	1923	1894	2016
SCHOOL-AGE						
Skilled	1929	1790	1957	1802	1917	1910
Unskilled	2479	2290	2066	2434	2116	2277
Mean	2204	2040	2012	2118	2017	2094
OVERALL	2062	2033	1928	2020	1955	2055

Table 17

Percentage of Silent /e/s Missed Around Clause Boundaries

COLLEGE-AGE	Clause Final	Clause Initial	Difference
Skilled	41	17	24
Unskilled	30	22	8
Mean	36	20	16
SCHOOL-AGE			
Skilled	15	5	10
Unskilled	19	17	2
Mean	17	11	6
OVERALL	29	17	12

Table 18

College Students' Clause Reading Times (msec) in Script-based Stories

	Script Relevance		
SKILLED READERS	High	Low	Average
Because	3103	3010	3057
Although	2779	2945	2862
Average	2941	2978	2960
UNSKILLED READERS			
Because	3358	3915	3637
Although	3209	3388	3299
Average	3284	3652	3468

Table 19

College Students' Sentence Recognition Scores for Critical Clauses in Script-based Stories

	Script Relevance		
SKILLED READERS	High	Low	Average
Because	6.00	5.31	5.65
Although	4.31	3.63	3.97
Average	5.16	4.47	4.81
UNSKILLED READERS			
Because	5.06	7.38	6.22
Although	3.44	5.06	4.25
Average	4.25	6.22	5.24
OVERALL	4.71	5.35	

NOTE: Scores range from 1-8, with 4.0 representing chance performance.